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TEN CLICK RULE: A Test of the Effectiveness of a New Rule for Simplifying Battle Field Sight Adjustment

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This note contains the preliminary evaluation of a new rule to be applied for sight adjustment in the field. The new "ten-click rule" involves the heuristic of using the front sight post as a measuring instrument. The sight post equals 10 clicks of sight adjustment. The distance (in clicks) that a bullet strikes from the intended aiming point can be assessed at any range using the 10-click rule. It was found that the 10-click rule generally produced significantly less error in sight adjustment than the presently taught range-computation method. The 10-

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20. Abstract (continued)

click rule also offers the advantages of being easily understood and recalled.

INTRODUCTION

The accuracy of the M16A1 rifle is dependent on how well the weapon has been "zeroed." Zeroing is adjusting the front and rear sights until bullets strike the target at the place where the sights are aimed. Due to the importance of this process, soldiers should have a high level of competency in this task. Historically, however, training soldiers how to zero has been a difficult task.

In early observations of marksmanship training, it was found that there was a lack of knowledge about and understanding of the zeroing process. Poor zeros were also observed for many soldiers, probably as a result of the general lack of understanding of the process (Smith, Osborne, Thompson, & Morey, 1980). Steps were taken to solve this problem. In the present marksmanship training program, soldiers learn to zero using a newly developed 25 meter scaled silhouette zeroing target. The new target was designed to simplify the zeroing process. A 25 meter target scaled to represent a target at 250 meters includes a coordinate grid system with each line representing one click of the sight (a click is equal to one minute of angle). Diagrams at the margins of the grid show which sight to change and the direction. By tracing the lines which cross closest to the soldier's shot group center back to the margins, the soldier knows which sight, which direction, and the number of clicks to make the correct sight adjustment. This process, although easy to understand, creates a dependence on the target itself, creating a potential problem when the soldier finds it necessary to adjust the sights in the field.

According to the Unit Rifle Marksmanship Guide (FC23-11), soldiers must be able to make sight adjustments at any range (i.e., without a zero target). The guide provides some information about how to make sight adjustments in the field. More specifically, the guide outlines a process incorporating several facts to aid sight adjustment. Basically there are three facts to know. First, one minute of angle is equal to one inch at 100 yards. Second, the ratio of one inch for 100 yards is constant at all ranges, i.e. a minute of angle is equal to two inches as 200 yards. Third, one click on the M16 is equal to one minute of angle. One heuristic is offered to help in range estimation. The front sight post is perceived to be equal to a man size target at 175 meters.

This experiment compares the adequacy of the above rule with the adequacy of a new rule developed by J. E. Schroeder (personal communication, March, 1985). The new rule states that the width of the front sight post is approximately equal to 10 clicks of sight change. This is a constant measure for all ranges; therefore, no range estimation is required and also no distance/click conversion. For example, if the bullet strikes half a sight post to the right of where you aimed (regardless of range) then move your sights five clicks to the right. It is hypothesized that the computation and knowledge required by the old rule makes sight adjustment quite difficult and results in less accuracy. This experiment was designed to compare the sight change accuracy produced by the current calculation method with the accuracy produced by the new "10-click rule."

EXPERIMENT 1

Method

Subjects. Subjects were 10 males and four females with no recent experience zeroing a weapon. All subjects had experience shooting a M16A1 rifle either in a simulator or live fire. Subjects were randomly assigned to the experimental group (*n* = 7) or the control group (*n* = 7).

Apparatus. The apparatus consisted of a dummy M16 rifle and a shot panel. The rifle was placed in a wooden cradle on a table and weighted by a sandbag for stabilization. The shot panel consisted of a paper panel held up by a steel tripod; a set of five 25m scaled targets for ranges of 100, 150, 200, 250, and 300m. Fifteen shot holes (three per target), were randomly placed in the paper panel with the constraint that none would be hidden from view when looking through the sights of the cradled weapon (see Figure 1 for actual placement). The target was placed on the center of the panel, facing toward the subject. A lamp was placed in front of the panel in order to increase visibility of the targets.

The holes in the paper panel had small flaps behind them so that the panel appeared solid to the subject. On each trial, the subject would be shown the location of a miss by shining a flashlight from behind the panel through one of the holes. On each trial, subjects were instructed to look through the sights of the weapon and cued about when the light would be turned on. A chair was placed beside the table for subjects to sit on during the experiment.

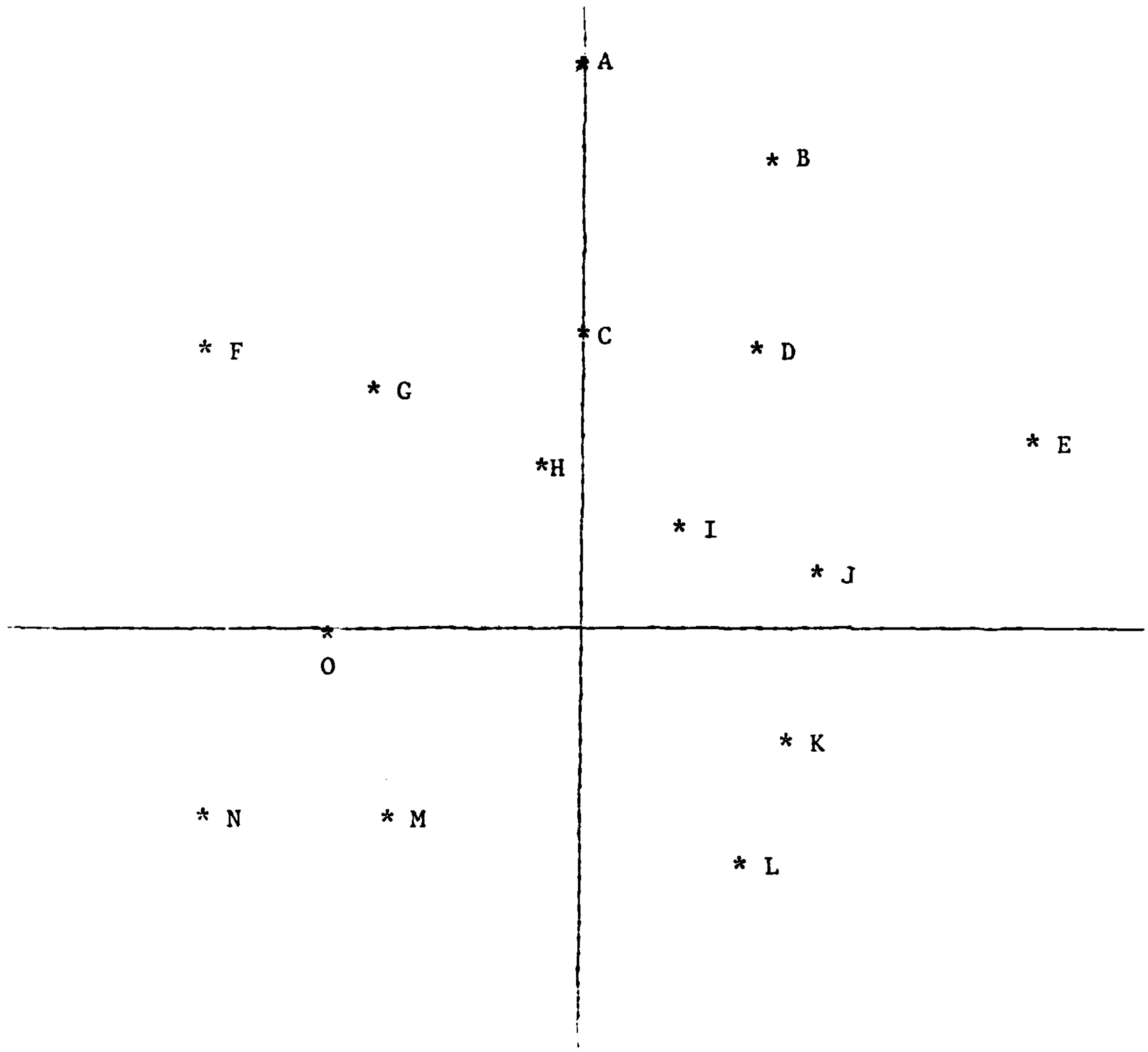

FIGURE 1. Shot placement on shot panel.

Procedures. Subjects were asked to sit beside the cradled M16A1 rifle in a position that was comfortable for firing. All subjects were read a set of formal instructions consisting of the purpose of the experiment, the purpose and brief explanation of the sight adjustment process, and instructions for their task in the experiment (see Appendix A for instructions).

All subjects were presented with a series of 15 shots. Their task was to estimate the sight change that would be required to move that shot to the center of the target. They were instructed to indicate the number of clicks and the direction (down-up, left-right) of the change for each of the two sights.

The experimental group was given the 10-click rule for estimating sight change and instructed to use that method to determine their answer. The control group was given the range computation method and instructed to use that method to determine their answer. Each subject was given one practice trial and then 15 test trials (three trials for each of five ranges). The order that subjects received the five ranges was randomized. However, once a target range was presented, all three miss locations were presented before going on to another target range. This was done to reduce the time that would be involved in changing the target each time. The location of the misses for each range were held constant but the sequential order of presentation was randomly changed for each subject. After completing the experiment, subjects were asked what method they had used to estimate the sight change.

For each trial, an individual's score was the radial distance from the center of the target to the location where the bullet would have hit using the subject's sight change. This score represents the error that would occur in the field by a soldier. Target scores were the average of the estimates from the three shots presented with that target. An overall score was computed by averaging all 15 individual scores.

Results and Discussion

T-tests were conducted to compare the performance of the experimental and control groups for different target ranges and overall. An *F*-test of the homogeneity of the sample variance showed heterogeneous variances for the overall test and for the 150m target. Due to the violation of the assumption of homogeneity of the variances, Mann-Whitney U's were computed. Table 1 summarizes the results from both the *t*-tests and the Mann-Whitney U's.

Table 1

Results of Experiment 1 (error data)

	Range-comp		Ten-click				
Grouping	M	SD	M	SD	F	t(df)	U
Overall	14.59	1.38	10.93	4.76	11.86*	1.96(7)	10
Target 1 100m	15.97	1.79	9.98	4.28	5.73	3.41(12)**	4**
Target 2 150m	18.01	1.91	17.09	14.64	59.03*	.17(6.2)	9
Target 3 200m	16.89	2.42	10.42	5.75	5.64	2.74(12)*	7*
Target 4 250m	10.17	1.26	7.15	2.17	3.00	3.17(12)**	4**
Target 5 300m	11.93	2.25	9.99	4.85	4.66	.96(12)	17

F-test of homogeneity of sample variance.

t-test between groups (independent samples).

Mann-Whitney U.

seperate variance estimate used for *t*-test.

$*p < .05$.

$**p < .01$.

The results were generally as predicted. The 10-click group did average significantly less error in their estimates than the range-computation group on three of the five targets. With such a small number of subjects, the data was highly subject to individual subject variation. One extreme subject was the probable cause of the nonsignificance for target two (150m) which could have created the difference in the overall means to be diminished.

Responses to the follow-up question indicated that those subjects in the 10-click group all used the 10-click rule, while six out of seven subjects in the range-computation group guessed at the answers.

EXPERIMENT 2

The results from Experiment 1 showed that the 10-click rule did generally produce significantly less error in sight adjustment when compared to the present range-computation method. However, significant improvement was not found on two target ranges. Closer inspection of the data indicated that one subject in the experimental condition caused the heterogeneity of variance and reduced the experimental effect. One possible explanation is that this subject may not have understood the 10-click rule. Consequently, one of the main purposes of Experiment 2 was to more directly check the understanding of the two rules in both groups.

Another important feature of a heuristic is its recallability. It is important for the soldier to not only be able to learn a rule with relative ease, but to also be able to recall it with the same amount of ease. Hence, another goal of Experiment 2 was to test the recallability of the two rules.

The third goal of Experiment 2 was to provide the original control subjects with the new 10-click rule, retest them on the same task, and test for any improvement or impairment in performance. Also by asking the subjects which rule they preferred, it was possible to obtain information about the relative acceptability of the new 10-click rule. It was predicted that subjects would prefer the 10-click rule over the range-computation method.

Method

Subjects. The subjects were the same who had participated in Experiment 1. One subject from the control group was unavailable for the range estimation task of the second experiment. Two subjects from the experimental group were unavailable.

Apparatus. The apparatus used in Experiment 1 for the sight change estimation was also used in Experiment 2.

Procedure. In Experiment 1, subjects were not told that they would be asked to recall the experiment or participate in any follow-up. After approximately four weeks, all subjects were first asked to recall the rule they received in the first experiment. They were then given feedback on the accuracy of their recall. In addition, to determine their level of understanding of the 10-click rule, subjects in the experimental (10-click) group were asked to complete a simple task using the 10-click rule which they received in Experiment 1. The test consisted of a shot location and a 25m scaled 250m target on a piece of white paper. The subjects used a piece of paper representing the width of the sightpost (10 clicks) to measure the sight change required.

Subjects in the original control (range-computation) group were given the 10-click rule. They were then asked to complete the same task as the experimental group (in Experiment 2) to ensure competency in using the rule. Finally, the control subjects were given the same sight estimation task that was used in Experiment 1 and subsequently asked which rule they thought was easier.

Results and Discussion

Responses to the recall question were again as predicted. Four of the seven subjects in the range-computation group remembered that their rule used some ratio for computation but only one subject remembered the correct formula. The other three subjects in that group did not remember any part of the rule. Four out of five of the 10-click group subjects (two were unavailable for questioning), remembered the 10-click rule precisely. The fifth subject was incorrect in recalling the number of clicks the sightpost represented. This was the same subject that caused the heterogeneity of variance in Experiment 1.

After given feedback on their recall, subjects in the range-computation group were given the 10-click rule and those in the 10-click group were corrected or given details that they did not recall. Next, all subjects in both groups were tested to confirm their understanding of the 10-click rule. Only one of the 12 subjects questioned missed the exact sight change on the paper task by more than one click. This ensured that virtually all subjects knew how to apply the rule.

T-tests were conducted comparing the performance of the control group subjects for both rule conditions. Again, an *F*-test of the sample variance showed heterogeneous variances for the overall scores and for target 5 (300m). Due to the violation of the assumption of homogeneity of variance, Wilcoxon matched-pairs signed-ranks tests were computed. As found in Experiment 1, the Wilcoxons produced similar results to the *t*-tests, see Table 2 for a summary.

As hypothesized, there was a significant improvement in performance under the 10-click rule. Subjects averaged significantly less error in their estimates with the 10-click rule than with the range-computation formula for overall score and four out of the five ranges. Target 5 (300m) again showed no significant decrease in errors.

Subjects' responses to the follow-up questions were as hypothesized. Five out of the six original control group subjects found the 10-click rule easier to use than the range-computation formula. The other subject found them equally easy to apply.

GENERAL DISCUSSION AND SUMMARY

Soldiers must be able to adjust the sights of their weapon in the field without the use of the zero target. The 10-click rule is only one possible alternate method to the range-computation method that could accomplish this. Others could include more extensive training using the present method, more actual live-fire practicing adjusting sights, or more field sight adjustment exercises; however, many of these may not be very cost effective. If a training rule is to be developed, there are certain needs that must be met in order to have an effective rule. This rule must be comprehendable, easy to explain, concise, quickly executable, and most important, it must be accurate. The 10-click rule has the potential to satisfy all these needs. Although this research was conducted with a small number of subjects, it does reflect support for further investigation into using the 10-click rule as a replacement to the presently used range-computation formula.

Table 2

Resuts of Experiment 2 (error data)

	Time 1		Time 2				
Grouping	*M*	*SD*	*M*	*SD*	*F*	*t*(df)	*Z*
Overall	14.30	1.11	9.11	3.43	9.48*	3.61(5)*	-1.99*
Target 1 100m	15.76	1.87	6.94	2.49	1.79	6.18(5)**	-2.20*
Target 2 150m	17.84	1.72	10.77	3.98	5.33	3.39(5)*	-1.99*
Target 3 200m	16.52	2.42	9.47	4.54	3.52	3.13(5)*	-1.99*
Target 4 250m	9.92	1.17	6.20	2.66	5.19	3.81(5)**	-1.99*
Target 5 300m	11.46	2.03	12.15	7.85	14.91*	-.23(5)	-.11

F-test of homogeneity of sample variance.

t-test between variables (paired samples).

Wilcoxon matched-pairs signed-ranks test.

*$p < .05$.

**$p < .01$.

REFERENCES

Smith, S., Osborne, A. D., Thompson, T. J., & Morey, J. C. Summary of the ARI-Benning Research Program on M16A1 Rifle Marksmanship. U.S. Army Research Institute, Research Report 1292, June 1980.

U.S. Army Infantry School, Unit Rifle Marksmanship Training Guide, Fort Benning, Georgia, August 1984.

APPENDIX A

Instructions for Experiment 1

APPENDIX

Instructions for Experiment 1

This is a study of how well you can zero the M16 rifle in the field.

Zeroing is the process of adjusting the sights of your weapon so that bullets hit where you aim. There are two sights on the M16. The front sight adjusts for elevation - moving the bullet up or down, and the rear sight adjusts for windage - moving the bullet left or right. A sight change is measured in minutes of angle or clicks. One click moves a bullet one minute of angle.

A. (control group) A minute of angle is equal to 1 inch for every 100 yards. In other words, one click will move a bullet 1 inch at 100 yards, 2 inches at 200 yards, 3 inches ar 300 yards, etc. For example, if you missed a 100 yard target center by hitting 10 inches to the right, then you should move your rear sight 10 clicks to the right. This same rule applies to both windage (left-right) and elevation (up-down).

B. (experimental group) The front sight post may be used as a guide to determine the number of clicks required for a sight change. The width of the post is equal to 10 clicks. This is constant for all ranges. For example, if you missed a target at any range by hitting to the right by a distance equal to the width of the front sight post, then you should move your rear sight 10 clicks to the right. This same rule applies for windage (left-right) and elevation (up-down).

Consider the target to be a standard E-type solhouette target that is approximately 20 inches wide.

In this experiment, a series of shot locations will be presented to you. After each hot, I want you to tell me the direction of the sight change and the number of clicks for each of the sights. In other words, if you were in combat, aimed at the center of the target, and missed, but saw the strike of the bullet, how would you adjust your sights to hit the center of the target? For example, if the shot is high and left of the target, a possible sight change could be down and to the right.

"Any questions?"

Now, without distrubing the lay of the weapon, look through the sights as you would ifd you were firing.

"Can you see the target?"
"Is the weapon aimed at center of mass?"

You will receive a total of 15 shot locations. Each shot location will be shown for two seconds. The time it takes you to answer is being measured but you are under no time limit, so take as much time as you need. I will announce each shot and then ask if you are ready. You will be given one practice shot.

"Any questions?"
"Ready?"